(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 101 550 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
19.01.2005 Bulletin 2005/03

(51) Int Cl.[7]: **B22D 17/22**, B22D 35/06

(21) Application number: **99830710.2**

(22) Date of filing: **15.11.1999**

(54) **Mould for injection moulding magnesium and alloys thereof**

Giessform zum Spritzgiessen von Magnesium und seine Legierungen

Moule pour le moulage par injection de magnesium et ses alliages

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(43) Date of publication of application:
23.05.2001 Bulletin 2001/21

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Description

[0001] The present invention relates to a mould for the injection moulding of metals such as magnesium and its alloys, and to an injection moulding process using such a mould.

[0002] More specifically, the latter includes a body in which at least one cavity is formed, reproducing the shape of the piece to be moulded, and at least one duct for feeding the molten metal into the cavity.

[0003] In the prior art, once the molten metal is injected, it solidifies in the feeding ducts as well as in the mould cavity. The ratio of the mass of the moulded piece to that of the total mass of solidified metal is typically around 0.5. This means that around half the material is wasted in each moulding cycle and must be recycled in special processes which are fairly complex and of not insignificant cost.

[0004] US-A-5 772 933 discloses a mold for plastics and aluminium diecasting having the features disclosed in the preamble of claim 1 which follows.

[0005] The object of the present invention is to counter the aforesaid disadvantages of the prior art.

[0006] This object is achieved according to the invention by providing a mould, and an associated moulding process having the characteristics claimed specifically in the subsequent Claims.

[0007] Advantages and characteristics of the present invention will become apparent from the detailed description which follows, with reference to the appended drawings, provided purely by way of non-limitative example, in which:

Figure 1 is a sectioned side elevation view of a mould according to the invention;
Figure 2 is a sectioned front elevation view of the mould of Figure 1;
Figure 3 is a plan view of the mould of the preceding drawings;
Figure 4 is an enlarged-scale view of a detail of the mould of the preceding drawings; and
Figure 5 shows a section taken on the line V-V of Figure 4.

[0008] A mould for the injection moulding of metals, such as magnesium and its alloys, has (see Figures 1-3) a body 10 which includes a first die 12 and a second die 14, arranged facing each other so as to form a cavity 16 reproducing the shape of a piece to be moulded. The body 10 of the mould also includes, in association with the die 12, a plurality of plates 18, 20, 22 which directly or indirectly define a plurality of ducts for introducing the molten metal into the cavity 16 and have a common initial portion 24 and separate end portions 26.

[0009] An external plate, indicated 18, supports an injection feed socket 28 having a first duct 30 formed therein which forms part of the common initial portion 24 of the feeding ducts. A distribution plate, indicated 20, has a second duct 32 formed in it, arranged in series with and substantially orthogonal to the first duct 30. An injector-support plate, indicated 22, carries a plurality of injectors 34 which define respective ducts running substantially orthogonally from the second duct 32 and constituting the separate portion 26 of each duct.

[0010] The distribution plate 20 is arranged in a cavity 36 defined by the external plate 18, by the injector-support plate 22 and by spacer bars 38, the height of which is greater than that of the distributor plate 20 and which extend between facing peripheral portions of the external plate 18 and of the injector-support plate 22. The plates 18, 20 and 22 and the bars 38 are fixed together by screws 40, while additional screws 42 enable the injection-support plate 22 to be fixed to the die 12. Ventilation holes 41 are formed in the bars 38 in order to prevent condensation from forming in the cavity 36. Spacer elements 44 and positioning elements 46 are arranged between the distribution plate 20 and the external plate 18 and the injector-support plate 22.

[0011] The feed socket 28, the distribution plate 20 and the injectors 34 have heating means, in particular electrical resistors 48, operable to keep the metal liquid in the respective portions 24, 26 of the feeding channels. Electrical resistors 48 are also arranged in some of the spacer elements 44.

[0012] The separate end portions 26 of the feed ducts also have respective selective interception means (see Figures 4 and 5) which include a stopper 50 able to slide transverse the flow direction of the metal. Each stopper 50 is mounted (see Figure 2) on the free end of a rod 52 of a piston 54 slidable in a cylinder 56 of a respective actuator member 57, which may be hydraulic or pneumatic, for example.

[0013] The cross sections of the portions 58 of the feed ducts downstream of the stoppers 50 become steadily larger (see figure 4) towards their ends opening into the mould cavity 16.

[0014] The mould also has means for monitoring and adjusting the temperature, in particular thermocouples 60 which are associated with the injector-support plate 22, the die 12 and the resistors 48, and are connected to a central control unit 62 which is able to conveniently adjust the heat generated by the various resistors 48 on the basis of information on the temperature from the thermocouples 60, in such a way that an operating temperature corresponding to the design value is achieved across all points of the mould. In order to achieve better temperature regulation, it has proved to be advantageous to fit each injector 34 (see Figure 2) with two separate resistors 48a, 48b, the first 48a being positioned between the plates 20, 22 and the second 48b being positioned between the plate 22 and the die 12.

[0015] In order to carry out an injection cycle in the mould described above, a molten metal-feeding nozzle 66, known per se, is applied (see figure 1) to the opening 64 of the feed socket 28, with the shape of the opening 64 preventing any penetration of air, loss of molten metal

or stoppage of the latter.

[0016] The molten metal, which is at a temperature of around 620-700°C, thus flows into the first duct 30, enters into the second duct 32 and from there separates into the ducts 26 formed in the various injectors 34, thereby being delivered into the cavity 16 until it is entirely full. This procedure is completed extremely quickly (it takes, for example, around 20-40 ms to inject 1,500 g of material) and under extremely high pressure, which can go as high as 800 bar. Thanks to the structure of the mould, the extremely high reaction forces generated by such pressure are mainly discharged onto the bars 38 and onto the external plate 18 and the injector-support plate 22, thus protecting the components most closely involved in the injection flow, which are undoubtedly more delicate.

[0017] The central control unit 62 controls the power output of the various resistors 48 in order to ensure that the metal is in a molten state at each point of the ducts, that is at a temperature over 600°C. At the same time, the average temperature of the mould, and that of the dies 12, 14 in particular, must be considerably lower (around 250°C) and that of the more sensitive parts, such as the control unit 62 and the actuator members 57, must be even lower (around 40°C).

[0018] In order to be able to obtain such a differentiated temperature pattern, various arrangements are used. In particular, thanks to the air in the cavity 36, the distributor plate 20, where the most heat is produced, is substantially thermally-insulated from the other plates, to which it is connected only by small thermal bridges constituted by the spacer elements 44 and the positioning elements 46, as well as by the injectors 34 and the feed socket 28.

[0019] The cylinders 56 of the actuator members 57 are mounted externally of the body 10 of the mould (see figure 3), thereby increasing the possibility of external heat dissipation, and have internal circuits (not shown in the drawings) for the circulation of a cooling fluid. Similar circuits could also be arranged in other components, such as the external plate 18 and the injection-support plate 22.

[0020] The wiring box 62 is also arranged to project from the body 10 of the mould in order to increase the possibility of heat dissipating outwards, and has insulating panels 68 interposed between it and the body and a perforated bar 70, which both reduce the heat flowing from the mould.

[0021] In addition, appropriate coupling means, such as the positioning elements 46 (see Figure 1) of the distribution plate 20 in respect of the injector-support plate 22, and the interstices 72 (see Figure 4) left in the area where the stopper 50 is mounted on the rod 52, enable the various elements to be kept correctly aligned, despite the effect of thermal expansion.

[0022] To return to the description of the injection moulding process, once the molten metal has filled the cavity 16, solidifying substantially instantly, the stoppers 50 are pushed by their respective actuator members 57 into positions whereby they intercept the ducts 26. The liquid metal which is in the portion of the ducts 26 upstream of the stoppers 50 is thus separated from the solidified metal in the downstream portions 58. It is advantageous if the stoppers 50 are force-fitted to the surfaces forming their seat, in order to avoid any air seeping into the metal.

[0023] Once the ducts have been blocked, the dies 12, 14 are opened and the moulded piece is extracted by a conventional method. When it is removed, the piece takes with it the fragments of metal which solidified in the downstream portions 58 of the ducts 26. These fragments - which do not hinder removal of the piece, thanks to their tapered shape - constitute the only portion of material which is wasted or must be recycled. The metal which remained in a liquid state in the upstream portion of the ducts will form the head of the flow of material to be injected for the next operating cycle.

[0024] In any case, the waste fragments make up only a tiny fraction - less than 5% - of the material injected into the cavity 16, while with prior art techniques the mass of the material wasted or to be recycled is about equal to that of the material injected into the cavity 16.

[0025] Naturally, the principle of the invention remaining the same, manufacturing details and embodiments may vary widely from those described purely by way of non-limitative example, without thereby departing from the scope of the invention. In particular, a mould structure of the type described above could be provided not just for one but for both the dies forming the mould cavity.

Claims

1. A mould for the injection moulding of metals, such as magnesium and its alloys, having a body (10) which includes at least first and second dies (12, 14) arranged facing each other so as to define at least one mould cavity (16) which reproduces the shape of the piece to be moulded, and at least one duct for feeding the molten metal into the cavity (16), which feed duct is fitted with heating means, said mould being **characterised in that** it includes a plurality of feed ducts with a common initial portion (24) and **in that** the said body (10) also includes a plurality of plates (18, 20, 22), associated with at least one of the said dies (12), through which the said feed ducts are formed, said plates (18, 20, 22) including an external plate (18) bearing an injection feed socket (28) in which a first section (30) of said common initial portion (24) is formed, a distribution plate (20) in which a second section (32) of said common initial portion (24) is formed, and an injector-support plate (22) carrying a plurality of injectors (34) each defining a respective passage constituting the separate portion (26) of each feed duct,

wherein said distribution plate (20) is arranged in a cavity (36) formed by the said external plate (18) and the injector-support plate (22) and by spacer bars (38) which are higher than the distribution plate (20) and extend between facing peripheral portions of the external plate (18) and the injector-support plate (22).

2. A mould according to Claim 1, **characterised in that** the said at least one feed duct has selectively operable interception means.

3. A mould according to Claim 2, **characterised in that** the said interception means include a stopper (50) which is slidable transverse the direction of flow of the metal in said duct.

4. A mould according to Claim 3, **characterised in that** the said stopper (50) is mounted on the free end of the rod (52) of a piston (54) slidable in the cylinder (56) of an actuator member (57).

5. A mould according to any of Claims 2 to 4, **characterised in that** the cross section of the portion (58) of feed duct downstream of the said interception means increases gradually towards the end opening into the mould cavity (16).

6. A mould according to Claim 1, **characterised in that** the said initial portion (24) is formed by a first section (30) and a second section (32) arranged in series with and substantially orthogonal to the first section (30), separate end portions (26) of the said feed ducts extending substantially orthogonally from the said second section (32).

7. A mould according to any preceding Claim, **characterised in that** the said heating means are electrical resistors (48).

8. A mould according to Claim 1, **characterised in that** the said feed socket (28) and/or the said distributor plate (20) and/or the said injectors (34) have heating means, in particular electrical resistors (48), operable to keep the metal liquid in the respective portions of feeding duct.

9. A mould according to Claim 1, **characterised in that** spacer elements (44) and positioning elements (46) are interposed between the said distributor plate (20) and the external plate (18) and the injector-support plate (22).

10. A mould according to any preceding Claim, **characterised in that** it has means for monitoring and adjusting the temperature.

11. A process for the injection moulding of metals, such as magnesium and its alloys, which requires the use of a mould according to any preceding Claim.

Patentansprüche

1. Form zum Spritzgießen von Metallen, wie z.B. Magnesium und dessen Legierungen, welche einen Körper (10) aufweist, der zumindest eine erste und eine zweite Pressform (12, 14) umfasst, welche einander zugewandt angeordnet sind, um zumindest einen die Form des zu gießenden Stücks reproduzierenden Formenhohlraum (16) zu definieren, und zumindest ein Rohr zum Einspeisen der Schmelze in den Hohlraum (16), welches Zuführrohr mit Heizmitteln ausgestattet ist, wobei die Form **dadurch gekennzeichnet ist, dass** sie eine Mehrzahl von Zuführrohren mit einem gemeinsamen Anfangsteil (24) umfasst und dass der Körper (10) auch eine Mehrzahl von Platten (18, 20, 22) umfasst, die mit zumindest einer der Pressformen (12) in Verbindung stehen und durch welche die Zuführrohre gebildet sind, wobei die Platten (18, 20, 22) eine Außenplatte (18) inkludieren, die eine Einspritzzuführbuchse (28) trägt, in der ein erster Abschnitt (30) des gemeinsamen Anfangsteils (24) gebildet ist, sowie eine Verteilerplatte (20), in der ein zweiter Abschnitt (32) des gemeinsamen Anfangsteils (24) gebildet ist, und eine Einspritzstützplatte (22), die eine Mehrzahl von Spritzdüsen (34) trägt, von denen jede einen jeweiligen, den separaten Teil (26) jedes Zuführrohrs bildenden Durchgang definiert, wobei die Verteilerplatte (20) in einem Hohlraum (36) angeordnet ist, der durch die Außenplatte (18) und die Einspritzstützplatte (22) sowie durch Distanzstücke (38) gebildet ist, welche höher sind als die Verteilerplatte (20) und sich zwischen einander zugewandten Umfangsteilen der Außenplatte (18) und der Einspritzstützplatte (22) erstrecken.

2. Form gemäß Anpruch 1, **dadurch gekennzeichnet, dass** das zumindest eine Zuführrohr selektiv betriebsfähige Abfangmittel aufweist.

3. Form gemäß Anpruch 2, **dadurch gekennzeichnet, dass** die Abfangmittel einen Stopper (50) umfassen, welcher quer zur Strömungsrichtung des Metalls im Rohr verschiebbar ist.

4. Form gemäß Anpruch 3, **dadurch gekennzeichnet, dass** der Stopper (50) am freien Ende der Stange (52) eines Kolbens (54) angebracht ist, welcher im Zylinder (56) eines Betätigungsglieds (57) verschiebbar ist.

5. Form gemäß einem der Ansprüche 2 bis 4, **dadurch gekennzeichnet, dass** der Querschnitt des stromabwärts von den Abfangmitteln gelegenen

Teils (58) des Zuführrohrs zum in den Formenhohlraum (16) mündenden Ende hin allmählich zunimmt.

6. Form gemäß Anpruch 1, **dadurch gekennzeichnet, dass** der Anfangsteil (24) durch einen ersten Abschnitt (30) und einen zweiten Abschnitt (32), der mit dem ersten Abschnitt (30) in Serie und im wesentlichen orthogonal zu diesem angeordet ist, gebildet ist, wobei sich separate Endabschnitte (26) der Zuführrohre im wesentlichen orthogonal vom zweiten Abschnitt (32) erstrecken.

7. Form gemäß irgendeinem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** die Heizmittel elektrische Widerstände (48) sind.

8. Form gemäß Anpruch 1, **dadurch gekennzeichnet, dass** die Zuführbuchse (28) und/oder die Verteilerplatte (20) und/oder die Spritzdüsen (34) Heizmittel, insbesondere elektrische Widerstände (48), aufweisen, welche dazu betriebsfähig sind, das Metall in den jeweiligen Teilen des Zuführrohrs flüssig zu halten.

9. Form gemäß Anpruch 1, **dadurch gekennzeichnet, dass** Distanzelemente (44) und Positionierelemente (46) zwischen der Verteilerplatte (20) und der Außenplatte (18) sowie der Einspritzstützplatte (22) eingeschoben sind.

10. Form gemäß irgendeinem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** sie Mittel zum Überwachen und Einstellen der Temperatur aufweist.

11. Verfahren zum Spritzgießen von Metallen, wie z.B. Magnesium und dessen Legierungen, welches die Verwendung einer Form gemäß irgendeinem vorhergehenden Anspruch erfordert.

Revendications

1. Moule pour le moulage par injection de métaux, comme le magnésium et ses alliages, ayant un corps (10) qui comprend au moins des première et seconde matrices (12, 14) agencées l'une face à l'autre de façon à définir au moins une cavité de moule (16) qui reproduit la forme de la pièce à mouler, et au moins un conduit pour alimenter le métal fondu dans la cavité (16), lequel conduit d'alimentation est muni de moyens de chauffage, ledit moule étant **caractérisé en ce qu'**il comprend une pluralité de conduits d'alimentation avec un partie initiale commune (24) et **en ce que** ledit corps (10) comprend aussi une pluralité de plaques (18, 20, 22), associées avec au moins l'unes desdites matrices (12), à travers lesquelles lesdits conduits d'alimentation sont formés, lesdites plaques (18, 20, 22) comprenant une plaque externe (18) supportant un manchon d'alimentation d'injection (28) dans laquelle une première section (30) de ladite partie initiale commune (24) est formée, une plaque de distribution (20) dans laquelle une seconde section (32) de ladite partie initiale commune (24) est formée, et une plaque de support d'injecteur (22) supportant une pluralité d'injecteurs (34) définissant chacun un passage respectif constituant la partie séparée (26) de chaque conduit d'alimentation, dans lequel ladite plaque de distribution (20) est agencée dans une cavité (36) formée par ladite plaque externe (18) et la plaque de support d'injecteur (22) et par des barres d'espacement (38) qui sont plus hautes que la plaque de distribution (20) et s'étendent entre les parties périphériques se faisant face de la plaque externe (18) et la plaque de support d'injecteur (22).

2. Moule selon la revendication 1, **caractérisé en ce que** ledit au moins un conduit d'alimentation a des moyens d'interception pouvant fonctionner sélectivement.

3. Moule selon la revendication 2, **caractérisé en ce que** lesdits moyens d'interception comprennent un arrêt (50) qui peut coulisser en travers de la direction de l'écoulement du métal dans ledit conduit.

4. Moule selon la revendication 3, **caractérisé en ce que** ledit arrêt (50) est monté sur l'extrémité libre de la tige (52) d'un piston (54) pouvant coulisser dans le cylindre (56) d'un élément d'actionnement (57).

5. Moule selon l'une quelconque des revendications 2 à 4, **caractérisé en ce que** la section transversale de la partie (58) du conduit d'alimentation en aval desdits moyens d'interception augmente graduellement vers l'extrémité débouchant dans la cavité de moule (16).

6. Moule selon la revendication 1, **caractérisé en ce que** ladite partie initiale (24) est formée par une première section (30) et une seconde section (32) agencée en série avec et sensiblement orthogonale à la première section (30), des parties d'extrémité séparées (26) desdits conduits d'alimentation s'étendant sensiblement orthogonalement depuis ladite seconde section (32).

7. Moule selon l'une quelconque des revendications précédentes, **caractérisé en ce que** lesdits moyens de chauffage sont des résistances électriques (48).

8. Moule selon la revendication 1, **caractérisé en ce que** ledit manchon d'alimentation (28) et/ou ladite plaque de distribution (20) et/ou lesdits injecteurs (34) ont des moyens de chauffage, en particulier des résistances électriques (48), pouvant fonctionner pour garder le métal liquide dans les parties respectives du conduit d'alimentation.

9. Moule selon la revendication 1, **caractérisé en ce que** les éléments d'espacement (44) et les éléments de positionnement (46) sont intercalés entre ladite plaque de distribution (20) et la plaque externe (18) et la plaque de support d'injecteur (22).

10. Moule selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**il a des moyens pour contrôler et régler la température.

11. Procédé pour le moulage par injection de métaux, comme le magnésium et ses alliages, qui nécessite l'utilisation d'un moule selon l'une quelconque des revendications précédentes.

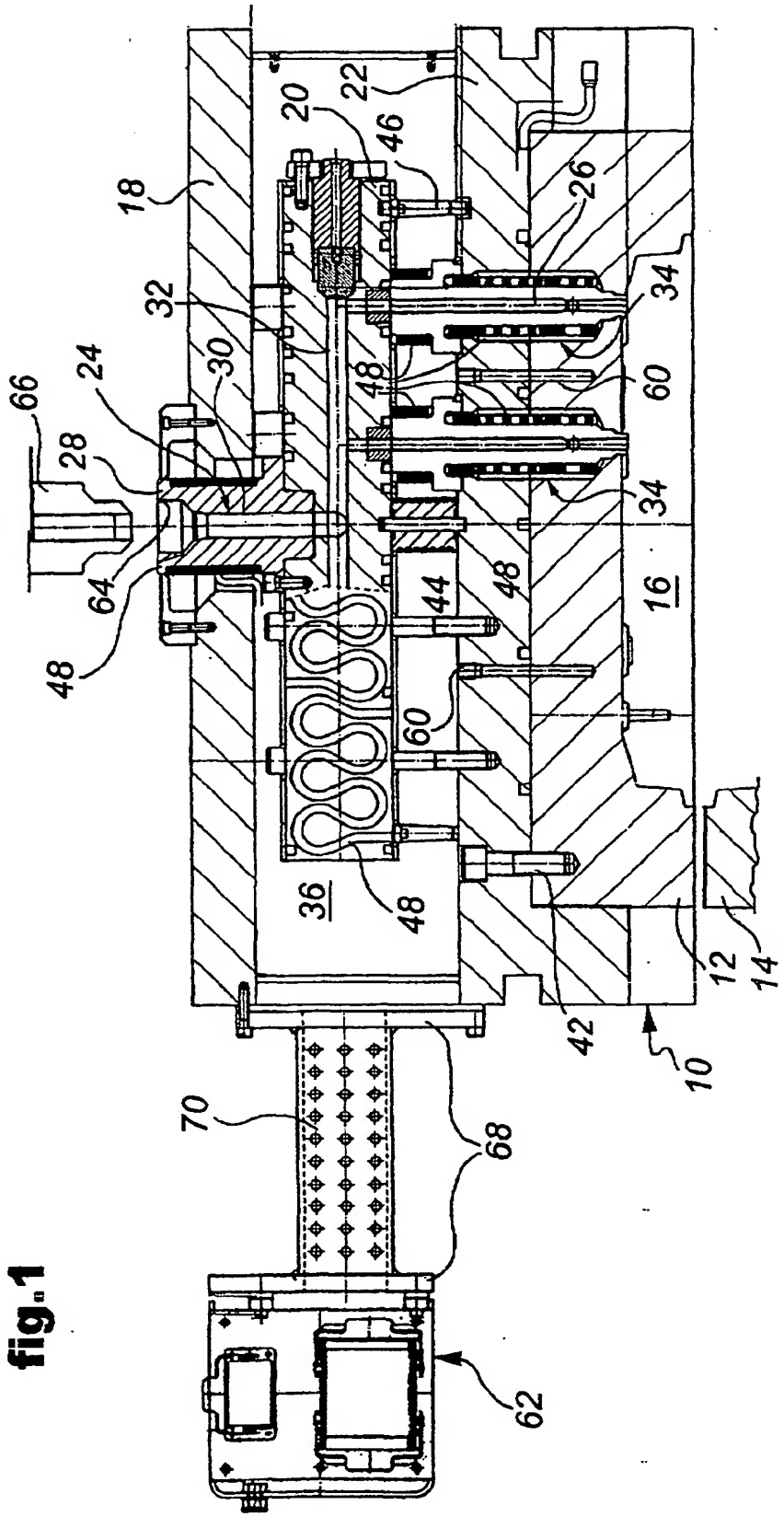

fig.1

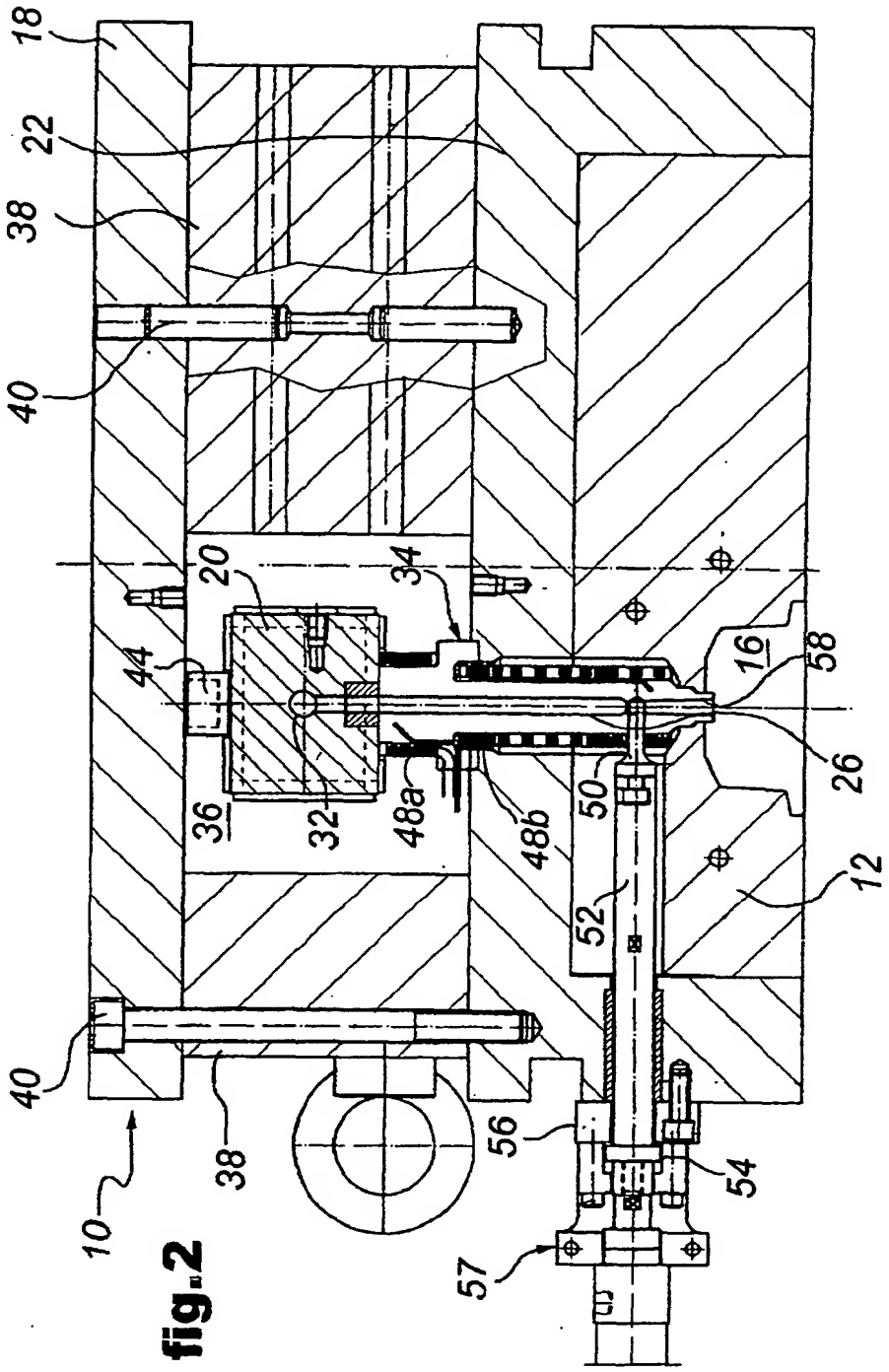

fig.2

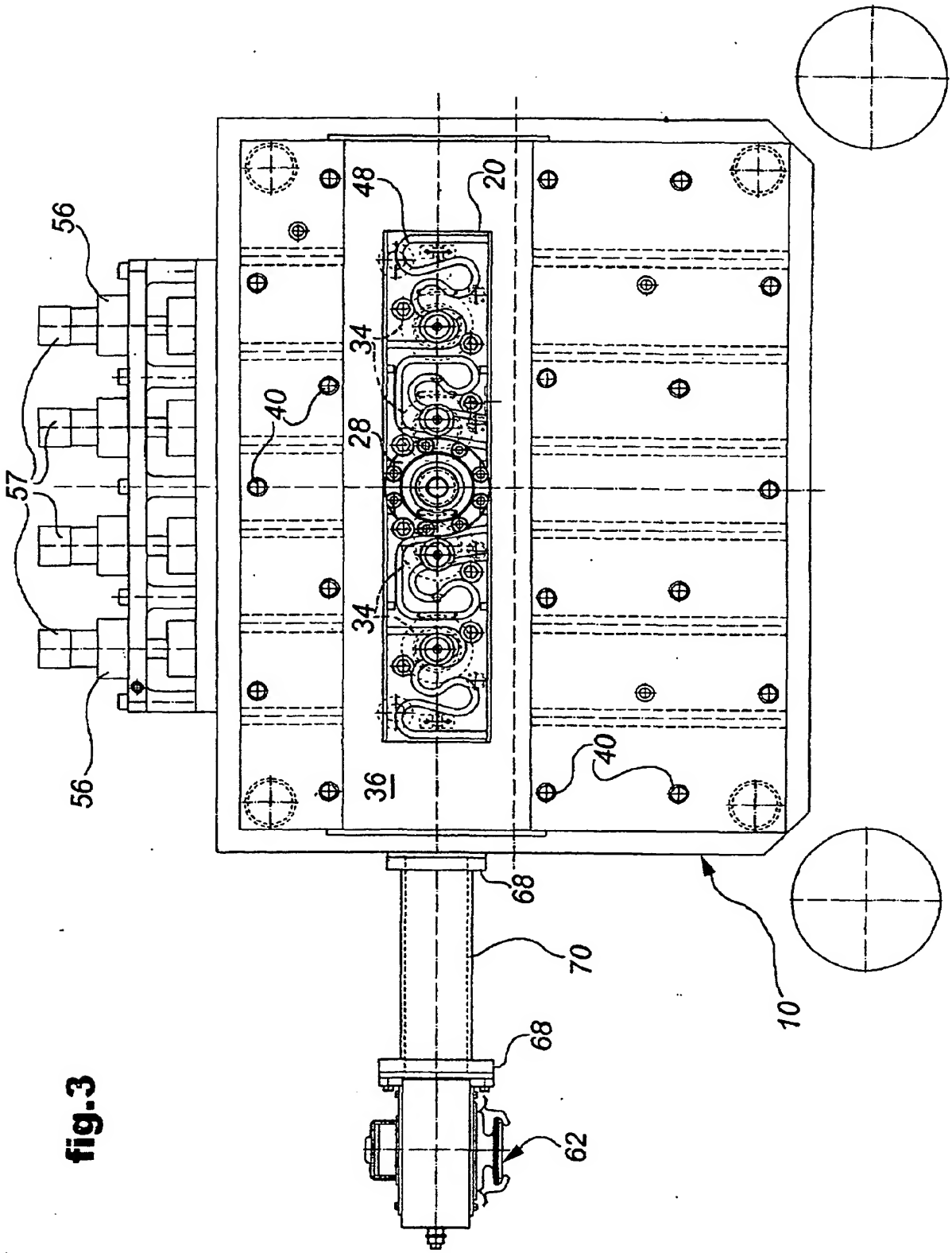

fig.3

fig.4

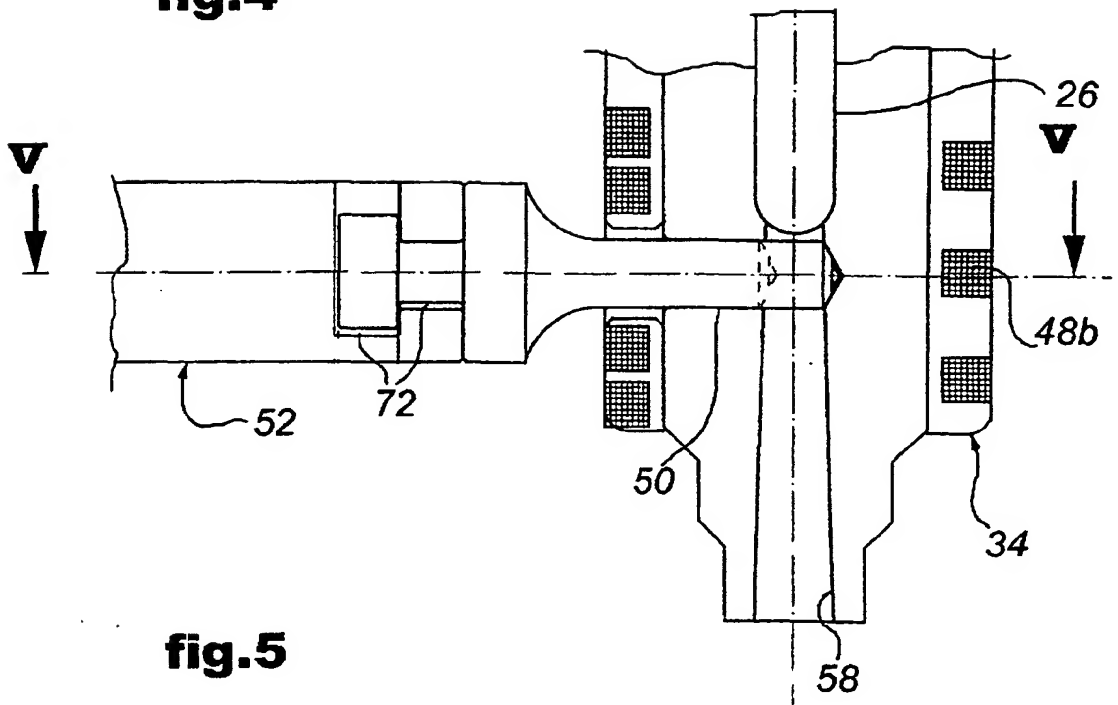

fig.5